

PRACTICE IMPROVEMENT BY IMPLEMENTING CEREBRAL OXIMETRY
DURING SHOULDER SURGERY IN THE BEACH CHAIR POSITION

by

Michael Crosley

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COLLEGE OF NURSING

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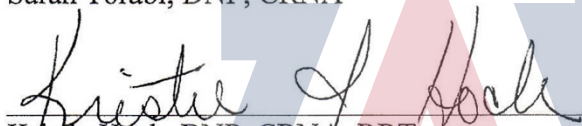
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GRADUATE COLLEGE

As members of the DNP Project Committee, we certify that we have read the DNP Project prepared by Michael Crosley entitled "Practice Improvement by Implementing Cerebral Oximetry During Shoulder Surgery in the Beach Chair Position" and recommend that it be accepted as fulfilling the DNP Project requirement for the Degree of Doctor of Nursing Practice.


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Final approval and acceptance of this DNP Project is contingent upon the candidate's submission of the final copies of the DNP Project to the Graduate College.

I hereby certify that I have read this DNP Project prepared under my direction and recommend that it be accepted as fulfilling the DNP Project requirement.


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DEDICATION

I dedicate this DNP project to my parents, Bruce and Lisa Snider. Without your love and support I would not be the man I am today. You taught me that nothing comes easy, but with perseverance, hard work, and little luck, you can accomplish anything.

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ABSTRACT

The beach chair position (BCP) is a reclined or sitting position at varying angles from 30-90° implemented for orthopedic shoulder arthroscopy and neurosurgical procedures. This position can lead to severe hemodynamic changes in the anesthetized patient due to marked decreases in cerebral blood flow (CBF) which increases the risk of cerebral tissue ischemia (Dippmann, Winge, & Nielsen, 2010). The use of cerebral oximetry during general anesthesia in the BCP allows the anesthesia provider to monitor brain tissue perfusion during all stages of anesthesia. Research indicates cerebral oximetry has the possibility of reducing postoperative complications, hospital length of stay, and allowing patients to quickly resume their activities of daily living (Abraham, 2014). The purpose of this Doctor of Nursing Practice (DNP) project was to identify barriers and evaluate the change in perceived benefit and implementation of cerebral oximetry for shoulder surgery in the BCP at a hospital in the Phoenix area. A pre and post-survey following an educational presentation identified barriers of implementing cerebral oximetry. Results from the post-survey revealed that 55.6% of providers (n=10) were not using cerebral oximetry even after the educational presentation on the benefits of this technology. On the post-survey, 89% of respondents (n=16) reported that they thought cerebral oximetry was potentially beneficial. Barriers to using cerebral oximetry were that cerebral oximetry was not available, 42% (n=18) or the provider did not have enough time to apply the monitor, 26% (n=11). Respondents also reported that surgeon interference, 14% (n=6) was a major barrier that prevented them from using cerebral oximetry. Results from this project show that anesthesia providers believe that cerebral oximetry may be beneficial to their patients but were limited in its implementation by several barriers.

INTRODUCTION

The human body is a complex system with multiple physiologic responses to maintain perfusion to vital organs. Receptors throughout the body respond to physiologic changes and work together to maintain homeostasis. However, medications and interventions used during surgery can inhibit these responses. For example, general anesthesia, muscle paralysis, and positive-pressure ventilation disrupt blood return to the heart and the mechanisms that auto regulate perfusion to the brain (Cassorla & Lee, 2015). Patient positioning, such as the beach chair position (BCP), further decreases perfusion. The BCP is a reclined, sitting position often utilized for shoulder arthroscopy. It provides superior access and joint mobility during shoulder surgery compared to the lateral decubitus position (Cassorla & Lee, 2015). However, in the anesthetized patient, this position has been associated with significant decreases in cardiac output, mean arterial pressure, and cerebral perfusion pressure (Murphy et al., 2010). Altered cerebral perfusion during surgery can cause severe neurologic complications such as stroke, loss of vision, and even brain death (Kocaoglu, Ozgen, Toraman, Karahan, & Guven, 2015). Multiple studies have shown that patients who experience low regional cerebral oxygenation (rSO₂) for an extended period of time, have a higher incidence of neuropsychological complications, increased length of stay, and increased cost (Vretzakis et al., 2014). Fortunately, there is technology available that is able to detect cerebral desaturation during general anesthesia.

Background Knowledge

The beach chair position is a reclined or sitting position developed for orthopedic shoulder arthroscopy and neurosurgical procedures. Positioning of the patient involves various angles above horizontal with the head secured in a headrest (Cullen & Kirby, 2007). This position provides superior access and joint mobility during shoulder surgery while also reducing

the incidence of brachial plexus injury when compared to the lateral decubitus position (Cassorla & Lee, 2015). However, this position can lead to severe hemodynamic changes in the anesthetized patient. Under normal conditions, the human body automatically responds to external variables, such as position changes, and regulates blood flow to vital organs. In the anesthetized patient, attenuated autonomic responses are further exacerbated from the vasodilatory effects of anesthetics. Under these conditions, the BCP can lead to severe reduction in mean arterial pressure (MAP), central venous pressure (CVP), cardiac output (CO), and the partial pressure of oxygen within the blood (PaO_2) (Cullen & Kirby, 2007). Consequently, these hemodynamic changes may lead to a decrease in cerebral perfusion pressure. Although there are some discrepancies, it is generally thought that cerebral blood flow is autoregulated and remains constant with a MAP of 65 to 150 mm Hg (Patel, Drummond, & Lemkuil, 2015). However, this is a generalized range and may not be accurate for those with comorbidities such as carotid artery disease.

Blood Pressure Monitoring

Another aspect to consider during general anesthesia in the BCP is the method of blood pressure monitoring. Shoulder arthroscopy is a relatively simple procedure that does not require intra-arterial blood pressure monitoring. Instead, intermittent monitoring is obtained with the use of a non-invasive blood pressure device placed on the non-operative arm. Modern day blood pressure cuffs use oscillometry to estimate MAP at the level of the cuff. However, this does not accurately reflect the blood pressure in the brain. Due to hydrostatic pressure gradient between the arm and brain, the blood pressure in the brain will be drastically lower than the arm (Cullen & Kirby, 2007). Mean arterial pressure decreases by approximately 2 mm Hg per inch above the heart (Thompson, 2014). If the external auditory meatus is ten inches above the heart, the

difference in blood pressure could be as high as 20 mm Hg. Therefore, a MAP of 65 mm Hg measured at the level of the heart translates to a MAP of 45 mm Hg at the level of the brain. This pressure is below the threshold of cerebral autoregulation and may place the patient at risk for severe neurological complications.

Cerebral Oximetry Concepts

Cerebral oximetry uses near-infrared spectroscopy (NIRS) to evaluate the oxygen saturation in the brain tissue below the sensor (Kocaoglu et al., 2015). Frans Jobsis first introduced the concept of using NIRS to monitor changes in cortical oxygenation in 1977. However, commercially available cerebral oximeters were not available until the 1990s (Fischer & Silvay, 2010). Cerebral oximetry has been used during cardiothoracic and vascular operations and has shown to be effective in identifying high risk patients, alerting providers to intraoperative alteration in cerebral oxygenation, and guiding interventions (Vretzakis et al., 2014).

Cerebral Oximeter Monitors

There are currently three devices that are approved by the United States Food and Drug Administration (FDA) for measuring cerebral oximetry: INVOS Cerebral Oximeter (Somanetics Corporation, Troy, MI), FORE-SIGHT Absolute Cerebral Oximeter (CAS Medical Systems, Inc. Branford, CT), and NONIN Regional Oximeter (Nonin Medical Inc., Plymouth, MN) (Fischer & Silvay, 2010). These devices utilize slightly different technology and measure either regional cerebral oxygenation (rSO₂) or absolute cerebral tissue oxygen saturation (SctO₂). The FORE-SIGHT Absolute Cerebral Oximeter has been found to be more accurate and does not require the provider to obtain a pre-anesthesia baseline reading (Fischer & Silvay, 2010). However, the majority of current literature is based on the INVOS Cerebral Oximeter. Only two of the articles

in the literature review used the FORE-SIGHT Absolute Cerebral Oximeter and zero used the NONIN Regional Oximeter.

The INVOS Cerebral Oximeter was the first device available in 1993 (Fischer & Silvay, 2010). This device uses disposable, light emitting diodes (LEDs) that emit light at 730 and 810 nanometers (nm) (Fischer & Silvay, 2010). Light detectors, set at a fixed distance from the LEDs, measure the amount of light returning to the sensor and calculate the regional cerebral oxygen saturation (rSO_2). This technology has primarily been used as a trend monitor in which clinical interventions were based on changes of rSO_2 from baseline (Fischer & Silvay, 2010). Therefore, when using a device that measures rSO_2 , a baseline value prior to induction is ideal.

The FORE-SIGHT Absolute Cerebral Oximeter, commercially available in 2007, uses a continuous wave of laser light in five wavelengths of 690, 730, 770, 810, and 870 nm (Fischer & Silvay, 2010). Light detectors measure the amount of light returning to the sensor and calculate the absolute cerebral tissue oxygen saturation ($SctO_2$). The additional wavelengths help to compensate for interference such as light absorption from fluid, tissue, or skin pigmentation and allows the provider to use threshold values to guide clinical interventions (Fischer & Silvay, 2010).

Cerebral Oximetry Application

Current cerebral oximetry technology estimates rSO_2 or $SctO_2$ through light emitting diodes placed over the frontal cortex. Near infrared light emitted at a frequency of 660 to 940 nm, easily passes through bone and tissue to be absorbed by hemoglobin (Fischer & Silvay, 2010). Estimation of cerebral oxygenation is based on the amount of light that returns to the light sensor. This measurement applies the Beer-Lambert law of absorption, which determines the concentration of a dissolved substance based on transmitted light intensity (Szocik, Barker, &

Tremper, 2015). The device interrogates cerebral tissue below the sensor which correlates to an arterial to venous ratio of 30:70 (Edmonds, 2014). Therefore, cerebral oximetry does not require pulsatile flow and values reflect the balance of oxygen delivery and consumption.

Accurate monitoring requires appropriate placement of the disposable sensors. The site of application is cleansed with an alcohol-based swab to remove excess skin oil from the patient's forehead. Each sensor is placed horizontally above each eye, adjacent to the edge of the hairline (Edmonds, 2014). This placement over the frontal cortex allows for monitoring of ischemia-susceptible tissue that lies between the anterior and middle cerebral arteries (Edmonds, 2014). However, this also limits the measurement of tissue oxygenation to a specific region and does not provide the overall cerebral oxygenation.

Cerebral Oxygenation

When using a device that measures rSO_2 , product recommendation is to obtain a baseline value prior to induction. Baseline numbers typically range from 60% to 90% for conscious, healthy adults (Vretzakis et al., 2014). Therefore, the abnormal range would be either less than 60% or greater than 90%. The anesthesia provider will monitor the cerebral oxygen saturation throughout the case and prevent cerebral desaturation. Cerebral desaturation events (CDEs) are defined as a 20% decline in rSO_2 from baseline (Deschamps et al., 2016). A 20% reduction of rSO_2 correlates with irreversible cell damage and should alert the provider to investigate the cause (Kocaoglu et. al., 2015). Studies have also shown that an absolute $SctO_2$ less than 50% is associated with postoperative cognitive dysfunction, higher incidence of stroke, and increased length of stay in an intensive care unit (Heringlake et al., 2017). Knowing this, cerebral oximetry may help to identify patients who are at risk for postoperative complications and alert the anesthesia provider to be more vigilant in maintaining cerebral perfusion. This technology

provides a non-invasive method of measuring cerebral oxygen saturation throughout the case and helps to guide the anesthesia provider.

Cerebral Oxygenation in Beach Chair Position

Recent studies that utilized cerebral oximetry during procedures in the beach chair position have found a high incidence of cerebral desaturation. One study by Kocaoglu et al. (2015), found that nearly half of their participants experienced a 20% reduction of cerebral oxygenation during shoulder surgery in the beach chair position. Another study found that despite their efforts to optimize cerebral perfusion pressure (CPP), 80% of their participants experienced a 20% decline in their rSO₂ (Murphy et al., 2010). Based on this data, the authors hypothesize that cerebral desaturation is a common occurrence during procedures in the sitting position (Murphy et al., 2010). Currently, a national clinical practice guideline (CPG) that recommends the use of cerebral oximetry during shoulder surgery in the beach chair position does not exist.

Strategies to Reverse Cerebral Desaturation

The cause of cerebral desaturation during general anesthesia is multi-factorial and may be difficult to identify. For patients in the BCP, the combination of positioning in the upright position, head fixation, and the effects of general anesthetics are often the cause (Aguirre, Marzendorfer, Brada, Saporito, Borgeat, & Buhler, 2016). Maintaining the head in a neutral position and optimizing oxygenation and perfusion is often sufficient for reversing cerebral desaturation (Deschamps et al., 2016). However, if cerebral tissue saturation does not improve, further investigation is required. Physiologic algorithms (Figure 1) have been developed to help ensure standardized strategies to reverse cerebral desaturation (Deschamps et al., 2016). Permission for reuse was obtained from Wolters Kluwer Health, Inc. (Appendix A).

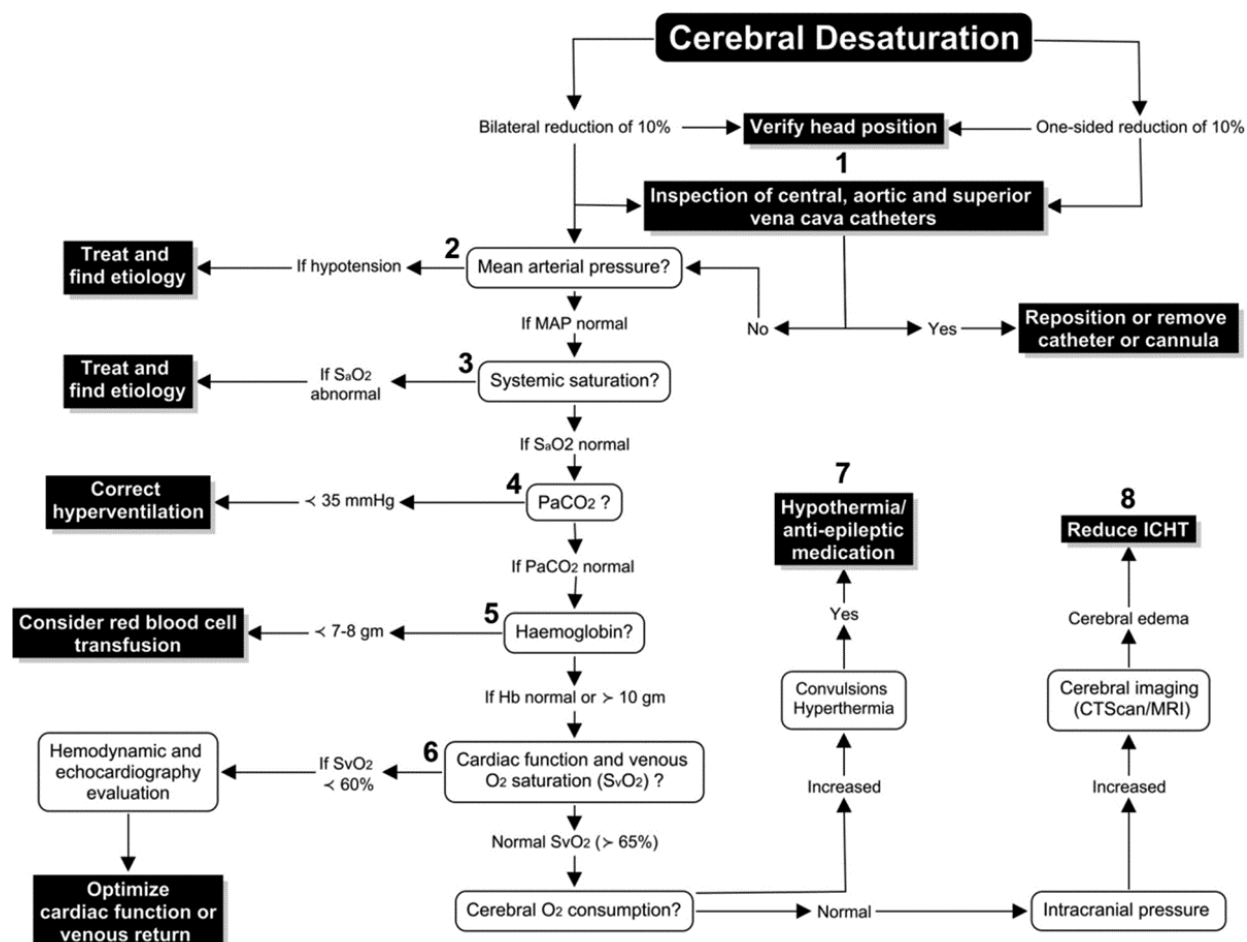


FIGURE 1. Physiologic algorithmic approach to the reversal of decreases in cerebral oxygen saturation. (Reprinted from Deschamps, A., Hall, R., Grocott, H., Mazer, D., Choi, P. T., Turgeon, A. F., ... Denault, A. (2016). Cerebral oximetry monitoring to maintain normal cerebral oxygen saturation during high-risk cardiac surgery. *Anesthesiology*, 124(4), 826-836. Reprinted with permission.)

Local Problem

The principle investigator of this DNP project identified a clinical practice improvement project after completing a clinical anesthesia rotation at an acute care hospital in Phoenix, Arizona. According to the literature review, cerebral oximetry has been routinely implemented for vascular and cardiac surgery, with increasing application for beach chair procedures. It was observed that cerebral oximetry was routinely used for cardiovascular surgery but was not for shoulder surgery in the BCP. This facility currently has three FORE-SIGHT cerebral oximeters. Two of the monitors are permanently stored in rooms designated for cardiac anesthesia and one mobile monitor is available as needed. This quality improvement project was developed to aid in the implementation of cerebral oximetry monitoring to prevent untoward consequences related to the BCP.

Significance to Advanced Practice Nursing

Advanced Practice Registered Nurses (APRNs), most notably, those who have obtained a Doctorate in Nursing Practice (DNP), are poised to be leaders through innovation and transformative change in healthcare. As independent practitioners, Certified Registered Nurse Anesthetists (CRNAs) are in a position to change healthcare through the implementation of current evidence. Cerebral oximetry is a simple adjunct monitor that has proven effective in identifying periods of cerebral desaturation (Kocaoglu, Ozgen, Toraman, Karahan, & Guven, 2015; Koh et al., 2013; Laflam et al., 2015; Lee et al., 2011, Moerman, De Hert, Jacobs, De Wilde, & Wouters, 2012; Murphy et al., 2010; Salazar, Sears, Andre, Tonino, & Marra, 2013). The use of this technology during general anesthesia in the beach chair position is another tool that allows the CRNA to provide safe and reliable care. Research indicates cerebral oximetry has the possibility of reducing postoperative complications, hospital length of stay, and allowing

patients to quickly resume their activities of daily living (Abraham, 2014). Increasing provider knowledge and implementation of cerebral oximetry may help ensure that patients are receiving evidence-based care and ultimately improve patient outcomes.

Purpose

The purpose of this DNP project was to identify barriers and evaluate the change in perceived benefit and implementation of cerebral oximetry for shoulder surgery in the BCP following an educational presentation. Identifying these barriers can lead to ways for improving implementation of cerebral oximetry with the goal of improved healthcare outcomes through translation of current knowledge into practice.

Project Questions

1. Will an educational presentation about cerebral oximetry and brain perfusion during BCP encourage implementation of this non-invasive monitor?
2. Will there be barriers identified for not implementing cerebral oximetry monitoring for patients having shoulder surgery in the BCP?

THEORETICAL FRAMEWORK AND SYNTHESIS OF EVIDENCE

Theoretical Framework

The theoretical framework (Figure 2) that guided this project was Rogers' Diffusion of Innovation (Rogers, 1995). This theory helped to understand the change process by focusing on the diffusion of innovation among individuals (Lundblad, 2003). The theory consists of four main elements: the innovation, communication, time, and the social system (Rogers, 1995). In other words, diffusion is the process by which an innovation is adopted within a social system over time (Estabrooks, Thompson, Lovely, & Hofmeyer, 2006).

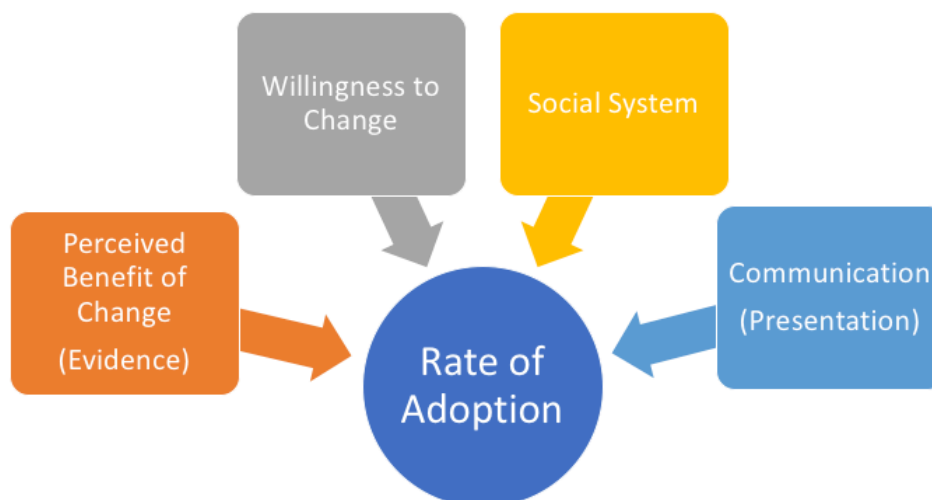


FIGURE 2. Variables that determine the rate of adoption. (Adapted from *Diffusion of Innovation, 4th Edition*, by Everett M. Rogers, 1995, Copyright 1995 by Everett M. Rogers.)

The first element to Rogers' theory is the innovation itself. Successful diffusion is dependent on whether the audience deems the change beneficial. This is a rather simple concept but highlights the importance of well-organized presentation supported by strong evidence. A convincing presentation regarding the use of cerebral oximetry may aid in successful diffusion throughout the group. Rogers identifies specific characteristics that determine the rate of adoption. These characteristics include relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1995). Anesthesia providers attending an educational presentation must be convinced that the use of cerebral oximetry will be beneficial. Otherwise, they will be less willing to change their practice and the innovation will be slow to spread.

The second element of the Rogers' theory is communication (Rogers, 1995). This is simply the process of sharing information between groups. For this project, the route of communication was through an educational presentation. It is of note that Rogers emphasizes the

importance of the relationship between presenter and audience during this phase. Rogers claims that the rate of diffusion is not based on the scientific merit but rather how the potential adopter views the person providing the information (Lundblad, 2003). This would suggest that diffusion of innovation is a social process and is more successful when the presenter is of similar background. Therefore, a presentation to fellow anesthesia providers in which a relationship has been established, may result in greater willingness to change practice.

Time is the third element in Rogers' theory and consists of: innovation-decision process, adopter categories, and the rate of adoption (Lundblad, 2003). The innovation-decision process is the timeline in which an individual learns of the innovation and decides to adopt or reject the change (Lundblad, 2003). This unique process varies between individuals based on their adopter category. The social system comprises those who embrace change and those who oppose change. Rogers defines this spectrum as innovators, early adopters, early majority, late majority, and laggards (Rogers, 1995). The innovators and early adopters are quick to change, whereas, the late majority and laggards are more traditional and resist change.

The final element of Rogers theory is the social system. Rogers emphasizes the importance of opinion leaders within a social system. These individuals are influential members at the center of the communication network and can be vital for innovation adoption (Lundblad, 2003). It is important to ensure the leaders and experts of the social system participate in the presentation of the use of cerebral oximetry. Their experience and opinion with the innovation may help to spread a positive attitude towards those who are less willing to change. The use of Rogers' Diffusion of Innovation Theory (Rogers, 1995) provided insight into the change process within a social system and may have resulted in a greater willingness to change.

Synthesis of Evidence

To better understand the benefits of using cerebral oximetry during shoulder surgery in the BCP, multiple literature searches were conducted through PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The initial search yielded 143 articles using the following key terms: shoulder arthroscopy, beach chair position, sitting position, cerebral oximetry. Filters applied to this inquiry limited the articles to human subjects with studies published within the last ten years. Based on the aforementioned criteria, 10 articles were selected based on their relevance to the study question. See Appendix B for complete analysis of the literature.

Strengths

The appraisal of evidence regarding the use of cerebral oximetry for shoulder surgery in the BCP revealed promising results. The studies found a significant reduction in blood pressure after the anesthetized patients were placed in the BCP (Aguirre et al., 2016; Koh, Levin, Chehab, & Murphy, 2013; Lee, Min, Chun, Kim, & Choi, 2011; Soeding, Wang, Hoy, Jarman, Phillips, Marks, & Royse, 2011). Additionally, the study by Laflam et al. (2015) found that patients in the BCP had diminished autoregulation of cerebral blood flow when compared to those in the supine position. With these side effects, it is not surprising that patients in the BCP were found to have lower rSO₂ and a higher incidence of CDEs (Kocaoglu et al., 2015; Koh et al., 2013; Laflam et al., 2015; Lee et al., 2011, Moerman, De Hert, Jacobs, De Wilde, & Wouters, 2012; Murphy et al., 2010; Salazar, Sears, Andre, Tonino, & Marra, 2013). These studies have identified significant side effects of the BCP that may lead to severe complications if they are not appropriately treated.

Weaknesses

Although the evidence supports the use of cerebral oximetry for shoulder surgery in the BCP, there are some weaknesses that must be addressed. A major weakness identified was that most studies were underpowered with a small sample size. The majority of the selected articles had a sample size ranging from 20 to 60 participants and only two articles had more than 100 participants in the study. Another weakness of the literature is the research design. A large majority of the studies were observational in design and had no randomization. Randomization of participants would be difficult and possibly unethical. The choice of anesthetic and patient positioning is based on optimizing surgical conditions and tailored to the patients' medical history (Laflam et al., 2015).

Gaps and Limitations

One major limitation is the lack of data on the magnitude or duration of cerebral desaturation that results in neurocognitive disorders. Many of the studies found in the literature review did not test for neurocognitive dysfunction or found no evidence of dysfunction. Despite the high incidence of CDE in the BCP, Murphy et al. (2010) found no obvious neurologic deficits in the study cohort. The authors contribute this to rapid intervention and limited duration of desaturation. One study did not specifically measure for postoperative cognitive dysfunction, but found that compared to the general anesthesia group, the sedation group had significantly improved Aldrete scores (post-anesthesia recovery score based on activity, respirations, circulation, neurologic status, and oxygen saturation (Odom-Forren, 2014)) and met discharge criteria 22.5 minutes quicker (Koh et al., 2013). Despite these limitations, the evidence for the use of cerebral oximetry in this population looks promising. The evidence shows a high

incidence of CDEs during shoulder surgery in the BCP. The use of cerebral oximetry allows for rapid identification and treatment of the event.

METHODS

Design

This DNP project obtained quantitative and qualitative data through a pre and post-survey following an educational presentation. Educating anesthesia providers about the risk of the BCP and the benefits of cerebral oximetry may help to improve their perception and willingness to change. The goal was to evaluate the change in perceived benefit and implementation of cerebral oximetry for shoulder surgery in the BCP following an educational presentation.

Setting and Participants

The setting for this project was a 268 bed, acute care hospital in Phoenix, Arizona that provides anesthesia for various procedures including orthopedic. Site authorization was obtained for this project (Appendix C). This project used a convenience sample of anesthesia providers (N=94) that is comprised of 34 anesthesiologists and 60 CRNAs. Potential participants were notified of project participation through a flyer posted in the staff break room one week prior to the meeting (Appendix D). The paper surveys were distributed during their weekly meeting to optimize the rate of participation. A description of the study and notice of voluntary participation accompanied the pre-survey.

Data Collection

Prior to collecting data, approval from the Institutional Review Board (IRB) at the University of Arizona and the participating hospital was obtained (Appendix E & F). Further oversight was not required from either facility. Data collection for this project was completed via a pre and post-survey (Appendix G & H). A survey developed by Zacharias, Lilly, Shaw, Pirundini, Rizzo, Body, and Longford (2014) was used as an outline and adapted to measure the aims of this project. Permission for reuse was obtained from Elsevier Inc. (Appendix I). A disclosure statement was attached to each survey (Appendix J). The pre-assessment, paper survey was distributed during a weekly provider meeting and included 11 questions in which four of these questions were demographic. The remaining seven questions were used on the pre and post-survey and consisted of multiple-choice (n=2), multiple-choice with option to provide rationale (n=4), and rank-order questions (n=1). The questions included a combination of closed and open-ended questions to determine current knowledge and perception of cerebral oximetry. Responses to survey questions remained anonymous and no personal identifying information was collected. The pre-survey required approximately 10 minutes to complete. An educational presentation developed by the primary investigator (PI) using current literature was presented to anesthesia providers on November 12, 2018 during a weekly meeting and required 30 minutes to complete. At the end of the presentation, the audience was encouraged to start implementing cerebral oximetry for shoulder surgeries performed in the BCP. At the conclusion of four weeks, a paper follow-up survey, consisting of seven questions was distributed to anesthesia providers during their weekly meeting. The follow up survey required approximately ten minutes to complete and participation was voluntary. The survey helped to identify barriers and strengths to implementation and perceived benefit from using this technology.

Data Analysis

The data obtained from this project was uploaded into Qualtrics, a web-based survey tool, and data analysis was conducted by the PI (Qualtrics, 2018). This tool allows for the identification of the distribution of data, as well as possible relationships between variables. Pre and post-survey responses were compared to identify changes following the educational presentation. Content analysis was used to analyze the qualitative data obtained from the open-ended questions (n=4). This allows for identification of prominent themes and patterns within the narrative data (Keller & Kelvin, 2013).

Ethical Considerations

The three principles that define the standard of ethical conduct in research include: the moral obligation to minimize harm, respect for human dignity, and justice (Polit & Beck, 2017). The pre/post-survey design accomplished the project aims while minimizing risks to the participants. Respect for human dignity was maintained by giving full disclosure to the purpose of the project and participants maintained the right to withhold information or withdraw from the study. Participation in the project was voluntary and recruitment targeted all anesthesia providers. Tests results were de-identified in order to maintain confidentiality. No other person had access to the data other than the PI and the project chair.

RESULTS

Demographics

Participants included a convenience sample of anesthesia providers (n=90) employed at the proposed site. On the day of the presentation, 26.6% (n=25), participated in the pre-survey. This sample included CRNAs (n=20) and anesthesiologists (n=5). The years of provider experience included 0-4 years (56%), 5-9 years (12%), 10-19 years (8%), and greater than 20 years (24%) (Figure 3). A follow-up survey was distributed four weeks after the pre-survey during the weekly provider meeting on December 12, 2018 (n=18). Of the available staff, 19.1% participated in the follow-up survey and no demographic data was collected.

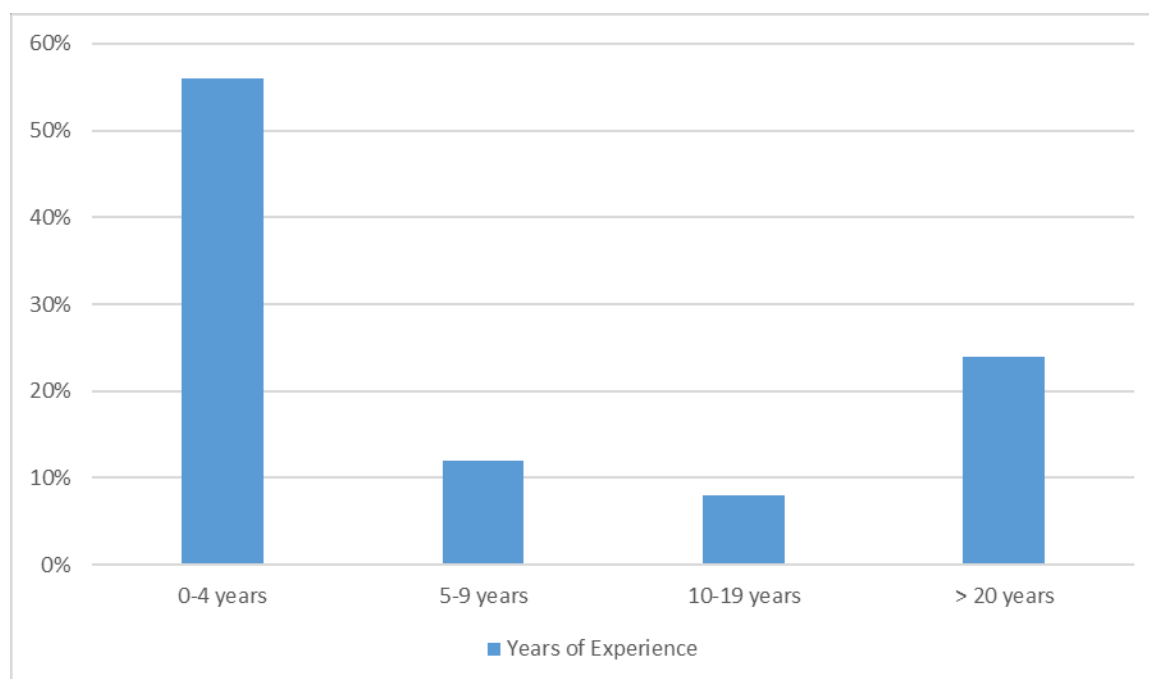


FIGURE 3. Years of experience of respondents.

Results Specific to Project Questions

The purpose of this DNP project was to improve healthcare outcomes through translation of current knowledge into practice. The goals were to identify barriers and evaluate the change in

perceived benefit and implementation of cerebral oximetry for shoulder surgery in the BCP following an educational presentation.

DNP Project Question 1

Will an educational presentation about cerebral oximetry and brain perfusion during BCP encourage implementation of this non-invasive monitor? In the pre-assessment survey, 64% (n=16) of providers stated they have not used cerebral oximetry for any cases during the last month (Figure 4). Another 24% (n=6) reported 1-4 cases and 12% (n=3) reported 5-10 cases during the last month. Of these cases, only two providers reported using cerebral oximetry for shoulders surgeries in the BCP. The follow-up survey included 18 respondents with 56% (n=10) stating they have not used cerebral oximetry for any cases during the last month. Another 33% (n=6) reported 1-4 cases and 11% (n=2) reported 5-10 cases within the last month. Only one provider reported using cerebral oximetry for shoulder surgery in the BCP.

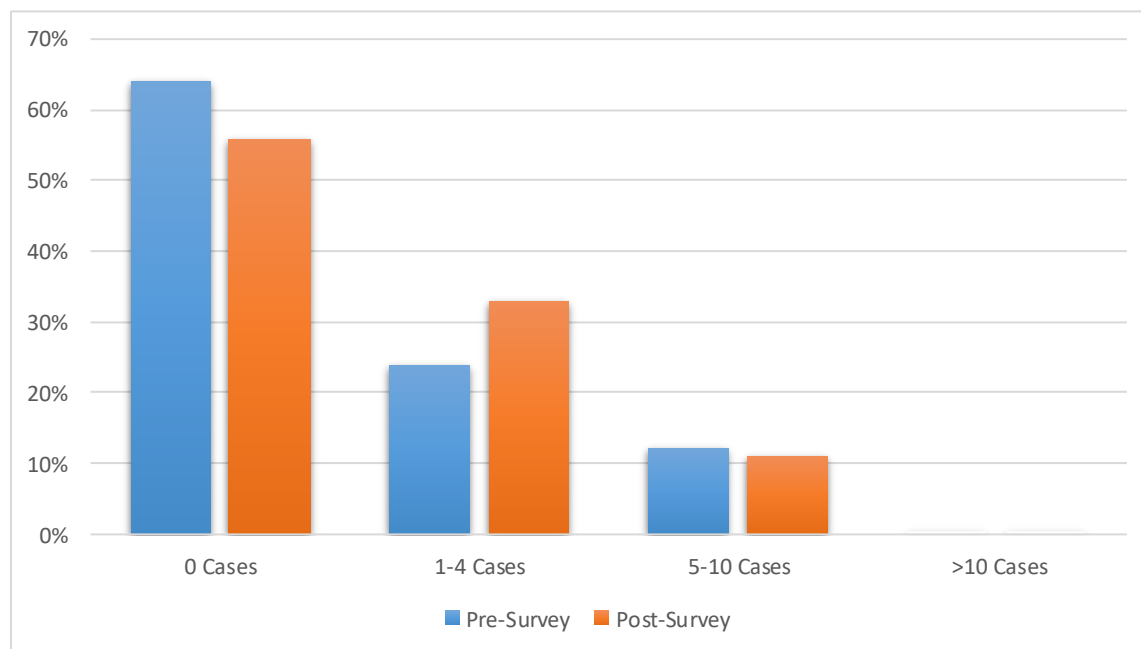


FIGURE 4. Comparison between pre and post-survey of the number of cases that cerebral oximetry was used during the previous month.

Further examining the first DNP question, providers were asked to identify specific cases in which they used cerebral oximetry (Table 1). Both the pre and post-survey identified infrequent use during orthopedic cases with 88% and 88.9% reporting never and 11.1% and 12% reporting rarely using cerebral oximetry. Additionally, both surveys identified limited use during vascular (Never 56% and 55.6%, Rarely 16% and 11.1%, Sometimes 20% and 33.3%, Often 4% and 0%, Always 0% and 0%) and thoracic cases (Never 68% and 66.7%, Rarely 12% and 16.7%, Sometimes 16% and 11.1%, Often 0% and 0%, Always 4% and 0%), but more frequent use during cardiac cases (Never 40% and 38.9%, Rarely 0% and 5.6%, Sometimes 16% and 5.6%, Often 12% and 11.1%, Always 8% and 16.7%).

TABLE 1. *Utilization of cerebral oximetry during general anesthesia.*

Frequency of cerebral oximetry use in specific surgical cases	Pre-survey (n=25)	Post-survey (n=18)
Orthopedic		
- Never	22 (88%)	16 (88.9%)
- Rarely	3 (12%)	2 (11.1%)
- Sometimes	0	0
- Often	0	0
- Always	0	0
- N/A	0	0
Vascular		
- Never	14 (56%)	10 (55.6%)
- Rarely	4 (16%)	2 (11.1%)
- Sometimes	5 (20%)	6 (33.3%)
- Often	1 (4%)	0
- Always	0	0
- N/A	1 (4%)	0
Cardiac		
- Never	10 (40%)	7 (38.9%)
- Rarely	0	1 (5.6%)
- Sometimes	4 (16%)	1 (5.6%)
- Often	3 (12%)	2 (11.1%)
- Always	2 (8%)	3 (16.7%)
- N/A	6 (24%)	4 (22.2%)
Thoracic		
- Never	17 (68%)	12 (66.7%)
- Rarely	3 (12%)	3 (16.7%)
- Sometimes	4 (16%)	2 (11.1%)
- Often	0	0
- Always	1 (4%)	0
- N/A	0	1 (5.6%)

TABLE 1 – *Continued*

Frequency of cerebral oximetry use in specific surgical cases	Pre-survey (n=25)	Post-survey (n=18)
Other		
- Never	17 (68%)	11 (61.1%)
- Rarely	2 (8%)	2 (11.1%)
- Sometimes	2 (8%)	0
- Often	0	0
- Always	0	0
- N/A	3 (12%)	1 (5.6%)

Examining the perceived benefit of cerebral oximetry, 72% of providers (n=18) reported on the pre-survey that they thought cerebral oximetry was either very (20%) or somewhat (52%) useful. On the follow-up survey, this number increased to 89% of respondents (n=16) with 16.7% reporting very useful and 72.2% reporting somewhat useful (Figure 5). In regard to the utility of cerebral oximetry during procedures in the BCP, 96% of providers (n=24) reported on the pre-survey that they thought cerebral oximetry was potentially beneficial compared to 89% (n=16) on the follow-up survey (Figure 6).

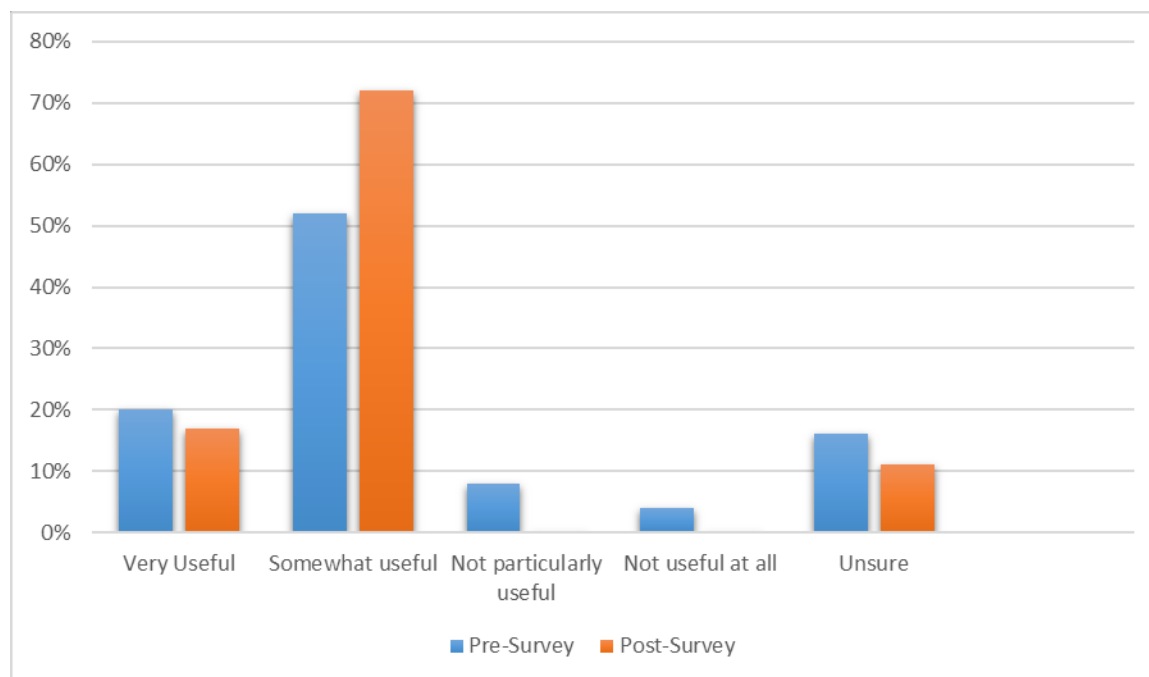


FIGURE 5. Comparison of perceived benefit of cerebral oximetry between the pre and post-survey.

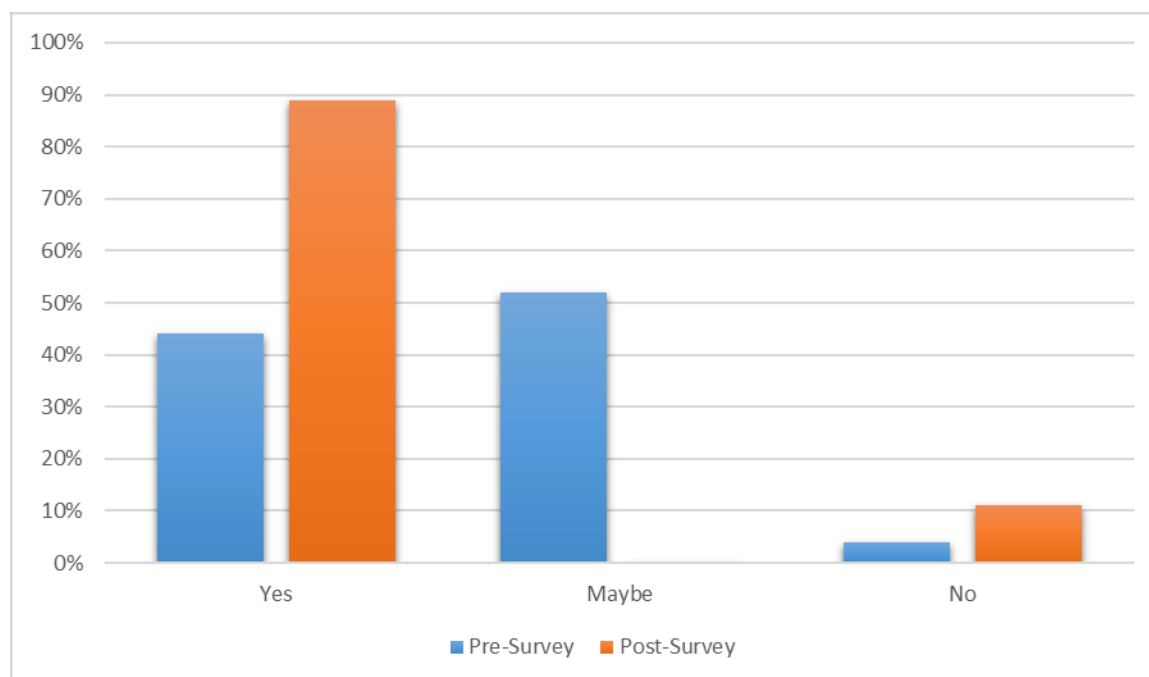


FIGURE 6. Comparison of perceived benefit of cerebral oximetry during shoulder surgery in the BCP between the pre and post-survey.

DNP Project Question 2

Will there be barriers identified for not implementing cerebral oximetry monitoring for patients having shoulder surgery in the BCP? For both surveys, the question assessing barriers to implementation was structured as a select the best answer, however, many respondents selected multiple answers. Therefore, all selected answers were accepted in order to assess the perceived barriers. Of the listed barriers on the pre-survey, 40% of respondents selected, “cerebral oximetry not available” (n=10), 24% selected, “lack of time” (n=6), 20% selected, “too much trouble to apply pads and obtain a baseline” (n=5), and 4% selected, “I do not believe there is a benefit to using cerebral oximetry (n=1). Of the respondents who participated in the post-survey, 44.5% selected, “cerebral oximetry not available” (n=8), 33.3% selected, “lack of time” (n=6), and 5.6% selected, “too much trouble to apply pads and obtain a baseline” (n=1) (Figure 7).

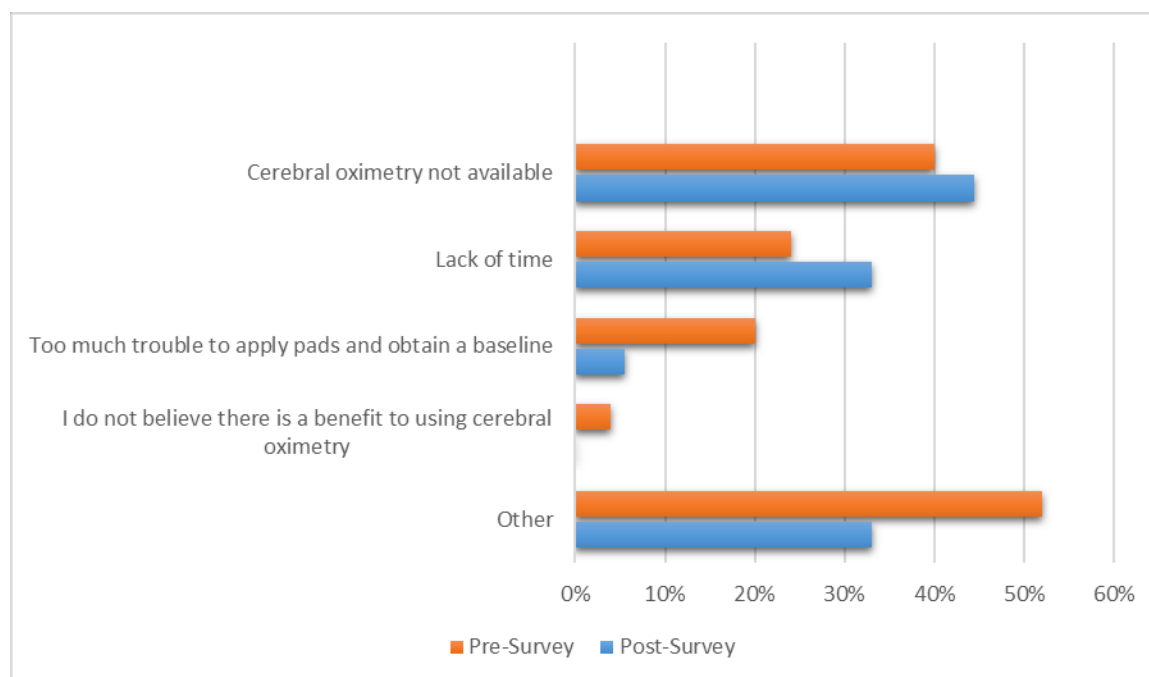


FIGURE 7. Perceived barriers for not implementing cerebral oximetry during shoulder surgery in the BCP.

Respondents were also allowed to report additional barriers that were not listed (Figure 8). Using content analysis, the subjective data obtained from the open-ended questions was grouped into categories based on prominent themes. Analysis of the pre-survey responses identified the following barriers: 24% reported, “surgeon interference” (n=6), 12% reported, “not standard of practice” (n=3), and 4% reported, “not involved in these cases” (n=1). Analysis of the post-survey responses identified the following barriers: 17% reported, “not involved in these cases” (n=3), and 6% reported, “never used cerebral oximetry” (n=1). Another 11% on the follow-up survey selected “other” but did not provide a rationale (n=2).

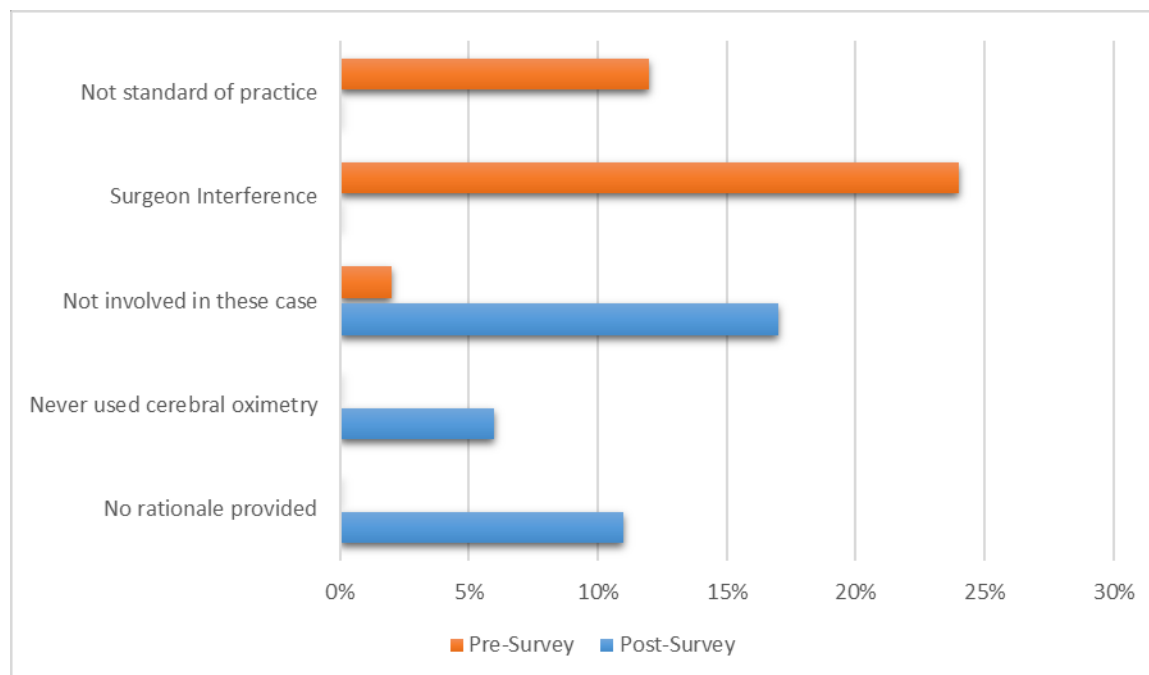


FIGURE 8. Additional barriers for not implementing cerebral oximetry during shoulder surgery in the BCP.

DISCUSSION

Shoulder surgery in the BCP is associated with severe hemodynamic changes that may lead to decreased cerebral perfusion. It is the responsibility of the anesthesia provider to utilize their skill, knowledge, and available medical devices to ensure the safety of each patient. This DNP project was designed to assess the current perception of cerebral oximetry and to identify barriers to implementing this technology during shoulder surgery in the BCP.

Results from the survey revealed that a majority of providers (55.6%) were not using cerebral oximetry even after the educational presentation on the benefits of this technology. Statistical analysis of the data showed that cerebral oximetry was more frequently used for cases such as cardiac (Never 40% and 38.9%, Rarely 0% and 5.6%, Sometimes 16% and 5.6%, Often 12% and 11.1%, Always 8% and 16.7%), rather than orthopedic (Never 88% and 88.9%, Rarely 12% and 11.1%, Sometimes 0% and 0%, Often 0% and 0%, Always 0% and 0%). This lack of

use did not appear to be due to lack of perceived benefit as a majority of respondents (pre 72%, post 89%) reported that they thought cerebral oximetry was potentially beneficial.

Multiple barriers to using cerebral oximetry during shoulder surgeries in the BCP were identified. Of those involved in this type of case, the most common barriers were that cerebral oximetry was not available (pre 40%, post 44.5%) or they did not have enough time to apply the monitor (pre 24%, post 33.3%). These barriers to implementation may be reduced with further education. There are three cerebral oximeters available at the participating facility with one machine available outside of the rooms designated for cardiac procedures. Furthermore, application of the monitoring pads is a simple task that takes only a few seconds once the provider is familiar with the process.

Anesthesia providers also reported that surgeon interference (pre 24%) was a major barrier that prevented them from using cerebral oximetry. This may be due to unfamiliarity of the device or concern for the monitoring pads and wires interfering with positioning. Future studies should include surgeons as key stakeholders in order to further assess this barrier.

Another significant barrier reported was that the use of cerebral oximetry during shoulder surgery in the BCP is not currently a standard of practice (post 12%). This may be due to a lack of evidence on the negative effects of CDEs during shoulder surgery in the BCP. Analysis of the current research revealed that many studies did not assess for neurocognitive dysfunction. As a result, the magnitude and duration of cerebral ischemia that results in postoperative neurocognitive dysfunction remains unclear (Salazar, Sears, Andre, Tonino, & Marra, 2013). Further research into the negative effects of CDEs may be necessary before this technology is accepted as a standard monitor.

Strengths and Limitations

A notable weakness of this project was the lack of consistent provider participation. Of the 94 anesthesia providers, 25 (26.6%) participated in the pre-survey and educational presentation. Multiple participants were not present for the follow-up evaluation thus leading to a low post-survey sample of 18 providers (19.1%). Increased provider participation could have provided a more accurate representation of provider perception of cerebral oximetry and barriers to implementation. Changes to the project methodology, such as an email-based survey may have increased provider participation. An email-based survey would have also ensured that respondents replied to questions as they were meant to be scored rather than provided multiple responses to a single response question.

The goals of this DNP project were to identify barriers and evaluate the change in perceived benefit and implementation of cerebral oximetry for shoulder surgery in the BCP following an educational presentation. Various barriers to implementation were identified through responses to the pre and post-survey. The perceived benefit appeared to improve following the educational presentation with an increase in providers reporting that cerebral oximetry is potential beneficial. However, the use of cerebral oximetry during shoulder surgery in the BCP did not significantly increase following the educational presentation.

Conclusion

Protecting the health and safety of our patients forms the foundation of the nursing Code of Ethics (American Nurses Association, 2015). Peri-operative brain damage is a devastating event that not only increases mortality, length of stay, and medical expense, but also decreases the patients' quality of life (Abraham, 2014). During general anesthesia, the anesthesia provider plays a pivotal role in protecting the patient from ischemic insults. The anesthesia provider must

employ their knowledge, skill, and experience, while also utilizing all reasonable equipment at their disposal in order to accomplish this goal. Cerebral oximetry is a non-invasive monitor that has shown to be effective at identifying cerebral desaturation during general anesthesia.

Rogers' Diffusion of Innovation Theory (Rogers, 1995) can be used to provide insight into the change process of the social system. Results from this DNP project show that anesthesia providers believe that cerebral oximetry may be beneficial to their patients, however, the use of this equipment is limited due to multiple barriers. Further adoption of this innovation will be dependent on influential members within the social system. Their expertise and opinion of the use of cerebral oximetry may help to break down barriers to implementation.

Further assessment is needed to include a larger sample of anesthesia providers. Based on the barriers identified, it may also be beneficial to include the orthopedic surgeons as well as those responsible for purchasing medical equipment for the department. Post-operative follow-up on the neurocognitive function of patients undergoing shoulder surgery in the BCP may help to solidify the need for this specific population.

Dissemination Plan

The findings from this DNP project will be presented at the 2019 Arizona Association of Nurse Anesthetists (AZANA) Sun and Fun conference in Scottsdale, Arizona. An overview of the project and the findings will be displayed using a poster board and PowerPoint presentation. The PI of this DNP project will be present to engage and educate key stakeholders including CRNAs and students.

DNP Essentials

Completion of this project fulfilled various DNP essentials as outlined by the University of Arizona's College of Nursing (The University of Arizona, 2019). DNP Essential I is based on

the scientific foundation of practice. This is accomplished by integrating nursing science, relevant practice theories, and new innovations to guide change to clinical practice. Roger's Diffusion of Innovation theory (Rogers, 1995) provided insight into the change process of a social system.

DNP Essential II involves evaluation of an organizations internal structure and resources with the aim of improving care delivery. The project identified barriers within the local hospital that potentially inhibit the use of cerebral oximetry during shoulder surgery in the BCP.

DNP Essential III requires critical analysis of current evidence to improve nursing practice. An educational presentation was developed based on current literature and presented to anesthesia providers with the aim of improving provider perception and utilization of cerebral oximetry. Anesthesia providers including CRNAs and anesthesiologist were educated on the benefits of cerebral oximetry and their participation in a pre and post-survey helped to identify barriers to implementation within their work environment. This interprofessional collaboration fulfilled the requirement of DNP essential VI.

DNP Essential VIII involves the advancement of nursing practice. This essential was met with the analysis of current evidence of cerebral oximetry and the potential benefits of its application to procedures in the BCP. Anesthesia providers were educated on the possible benefits and utility of cerebral oximetry for shoulder surgery in the BCP.

APPENDIX A:
LICENSE AGREEMENT FOR PHYSIOLOGIC ALGORITHM

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APPENDIX B:
EVIDENCE APPRAISAL

Reference	Research Question and Hypothesis	Study Design	Sample (N)	Methods for Data Collection and Data Analysis	Findings	Limitations
<p>Aguirre et al., 2016</p> <p>Cerebral oxygenation in the beach chair position for shoulder surgery in regional anesthesia: Impact on cerebral blood flow and neurobehavioral outcome.</p>	<p>Aim to evaluate the prevalence of regional cerebral oxygen desaturation in patients undergoing shoulder surgery in the BCP under regional anesthesia with conscious sedation and controlled hypotension (SBP 80-100).</p> <p>Hypothesis: NIRS reliably detects changes in cerebral oxygenation during regional anesthesia in the BCP and that the incidence of cerebral desaturation events would correlate with CBF impairment and neurobehavioral decline.</p>	Prospective, observation, assessor-blinded cohort study.	<p>N = 40</p> <p>Patients undergoing shoulder surgery in the BCP under regional anesthesia.</p>	<p>Primary: Incidence of CDEs (expressed as a drop of absolute rScO₂ (INVOS) to a value of <55% for >15 seconds of baseline or a decrease in rScO₂ >20% compared with the baseline value)</p> <p>Secondary: Effects of blood pressure (measured at acoustic meatus) on rScO₂, the effects of the CDEs on the neurological (pupil size and reaction, lateralization tests of both extremities, Glasgow Coma Scale, Mini mental State Examination test) and neurobehavioral outcome (Trail Making Test A and B, Grooved Pegboard), and the effects of BCP on CBF and the correlations between CDEs, neurobehavioral, and CBF decline.</p>	<p>The incidence of CDE was 5%. All patients had a significant drop in blood pressure ($p < 0.5$) after BCP. There was no decrease in regional cerebral saturation ($P = 0.136$) or the maximal blood flow in the MCA ($P = 0.212$).</p> <p>Two of three neurocognitive tests showed impairment 24 hours after surgery ($P < 0.001$ for TMT A and B test)</p> <p>No significant change in the neurological tests.</p>	<p>Lack of control group</p> <p>Neurocognitive tests were performed only once 24 hours after surgery</p> <p>CBF only measured by the middle cerebral artery blood flow and did not measure vertebral artery.</p>
<p>Kocaoglu et al., 2015</p> <p>Foreseeing the danger in the beach chair position: Are standard measurement methods reliable?</p>	<p>Aim: To show whether peripheral perfusion monitoring methods reflect central perfusion during shoulder arthroscopy during shoulder surgery in the beach chair position (BCP).</p> <p>Hypothesis: mean arterial pressure (MAP), central heart rate (CHR), and peripheral oxygenation (SaO₂) measured individually</p>	Non-experimental descriptive correlation study	<p>N = 53</p> <p>Median age: 58 (42-68)</p> <p>Patients undergoing arthroscopic rotator cuff repair in the beach chair position</p>	<p>Regional cerebral oxygenation was continuously monitored (INVOS) with the use of NIRS (RrSO₂ and LrSO₂). MAP, CHR, SaO₂, and cerebral oxygenation were recorded at six intervals (T1 = before induction, T2 = 5 minutes after induction, T3 = 5 minutes after BCP, T4 = 30 min after starting the operation, T5 = 60 min after starting the operation, T6 = and 5 min after returning to supine after surgery) and the correlation and differences between parameters was evaluated.</p>	<p>RrSO₂ dropped > 20% in 28.3% (T2-T3) and 45.3% (T2-T4) of the patients.</p> <p>LrSO₂ dropped >20% in 20.8% (T2-T3) and 43.4% (T2-T4) of the patients.</p> <p>SaO₂ values were significantly different from cerebral saturation values ($p < 0.001$).</p> <p>There was a correlation between cerebral saturation and MAP values ($p < 0.05$)</p>	<p>Did not perform neurocognitive tests to evaluate the relationship between CDE and cognitive function.</p> <p>No control group.</p>

Reference	Research Question and Hypothesis	Study Design	Sample (N)	Methods for Data Collection and Data Analysis	Findings	Limitations
	will not parallel cerebral oximetry measurements by near-infrared spectroscopy (NIRS)					
Koh et al., 2013 Neer award 2012: Cerebral oxygenation in the beach chair position: A prospective study on the effect of general anesthesia compared with regional anesthesia and sedation	<p>Aim: To examine the effects of general anesthesia on CDEs in patients having shoulder surgery in the BCP.</p> <p>Hypothesis: the awake patients would have less CDEs during procedures in the BCP compared with the patients under general anesthesia.</p> <p>Independent variable: ISB and general anesthesia with mechanical ventilation</p> <p>Dependent variable: CDE = Scto2 decreased > 20% from baseline</p>	Prospective study	<p>N = 60</p> <p>Intervention: Asleep group (30) - participants received interscalene block (ISB) with general anesthesia and mechanical ventilation</p> <p>Control: Awake group (30) - participants received ISB and sedation with spontaneous ventilation</p>	Scto2 (FORE-SIGHT cerebral oximetry), EEG, MAP (Brachial NIBP), HR, SpO2, BIS (Bispectral Index)	<p>73.3% of asleep patients required an intervention for >20% decrease in MAP compared with 10% of awake patients.</p> <p>Scto2 values were significantly lower at multiple time points for the asleep group compared to the awake group ($p < 0.001$). Incidence of CDEs was significantly higher in the asleep group (56.7%) as was the incidence per patient (2.4 in asleep vs 0 awake, all $P < 0.0001$).</p> <p>The incidence of absolute Scto2 < 55% was 23.3% in the asleep group compared with 3.3% in the awake group ($P = 0.52$). The combined CDEs was 89 in the asleep group vs 1 in the awake group ($P < 0.0001$).</p> <p>Aldrete recovery room scores significantly better for the Awake Group for the first 45 minutes ($P < .0006$)</p> <p>Awake Group met discharge criteria 22.5 minutes earlier than the Asleep group ($P < .007$)</p>	<p>No randomization for group assignment.</p> <p>No assessment of postoperative cognitive dysfunction.</p>

Reference	Research Question and Hypothesis	Study Design	Sample (N)	Methods for Data Collection and Data Analysis	Findings	Limitations
<p>Laflam et al., 2015</p> <p>Shoulder surgery in the beach chair position is associated with diminished cerebral autoregulation but no differences in postoperative cognition or brain injury biomarker levels compared with supine positioning: The anesthesia patient safety foundation beach chair study.</p>	<p>Aim: Identify if there is relationship between the BCP and cerebral autoregulation. A secondary aim is to identify if there is a relationship between diminished autoregulation and postoperative cognitive dysfunction and/or serum biomarkers.</p> <p>Hypothesis: Patients undergoing shoulder surgery in the BCP are more likely to have diminished CBF autoregulation manifest as higher COx than those having surgery in the LDP.</p>	Observational study	<p>N = 218</p> <p>BCP: Shoulder surgery in the beach chair position (n=109)</p> <p>LDP: Shoulder surgery in the lateral decubitus position (n=109)</p>	<p>rSco2 (INVOS 5100), MAP (Finometer Pro), COx (A continuous, moving Pearson correlation coefficient calculated between MAP and rSco2)</p> <p>Psychometric testing performed before surgery, 7-10 days after surgery, and 4-6 weeks after surgery (NIH stroke scale, Rey Auditory Verbal Learning Test, Brief Visuospatial Memory Test-Revised, Controlled Oral Word Associated Test, Symbol Digits Modalities Test, Trial Making B, Grooved Pegboard Test).</p> <p>Serum S100B, neuron-specific enolase, and glial fibrillary acidic protein measured at baseline, after surgery, and 1 day after surgery.</p>	<p>Average rSco2 was lower in the BCP group than in the LDP group (P<0.0001).</p> <p>Average blood pressure was higher (P=0.003), but estimated blood pressure at the tragus was lower (P<0.0001) in the BCP group</p> <p>Patients in the BCP had higher Cox (P=0.035), indicating diminished autoregulation.</p> <p>No difference in composite cognitive outcomes between groups.</p> <p>No difference in serum concentrations of brain injury biomarkers between groups.</p>	<p>Observation study design with no randomization</p> <p>Differences in demographics and case complexity between groups</p>
<p>Lee et al., 2011</p> <p>Effects of beach-chair position and induced hypotension on cerebral oxygen saturation in patients undergoing arthroscopic shoulder surgery.</p>	<p>Aim: Primary - To investigate the effects of the BCP and induced hypotension on rSO2 in patients undergoing shoulder arthroscopy. Secondary – investigate the relationship between change in rSO2 and postoperative cognitive dysfunction.</p>	Prospective	<p>N = 28</p> <p>Patients undergoing shoulder surgery with general anesthesia in the BCP. Attrition Rate: 3.57%</p> <p>One participant removed because the</p>	<p>rSO2 (INVOS 5100), MAP (arterial line measured at the external auditory meatus). rSO2 and MAP measured at T1 (baseline), T2 (after BCP), T3 (after induced hypotension), T4 (1 hour after induced hypotension), T5 (after return to supine). Cognitive dysfunction (Mini Mental State Examination) examined before surgery and 1 day after surgery</p>	<p>rSO2 values at T2, T3, and T4 were significantly lower than that at T1 (P<0.05).</p> <p>MAP values at T2, T3, and T4 were significantly lower compared to T1 (P<0.05) and T3 and T4 were significantly lower than T2 (P<0.05)</p> <p>There were two CDE (20% reduction in rSO2 from baseline) during the study period.</p>	<p>No control group or comparison to other methods of anesthesia.</p> <p>The authors list the use of NIRS as a limitation in that it reflect regional cerebral oxygenation rather than global measure.</p> <p>The Mini Mental</p>

Reference	Research Question and Hypothesis	Study Design	Sample (N)	Methods for Data Collection and Data Analysis	Findings	Limitations
	Hypothesis: The BCP and induced hypotension would reduce rSO ₂ by greater than 10%.		procedure changed from arthroscopic to open surgery.		No cognitive dysfunction was observed.	State Examination does not completely evaluate cognitive function
Moerman et al., 2014 Cerebral oxygen desaturation during beach chair position.	Aim: Evaluate the prevalence of CDE during general anesthesia in the BCP and identify causal factors of cerebral desaturation	Prospective, observational, blinded study	N = 20 Patients undergoing shoulder surgery with general anesthesia in the BCP.	rScO ₂ (INVOS 5100) measured at different time points (awake, last value before position change, 5 min after position change) Heart rate, non-invasive blood pressure (cuff on opposite arm of operation), and end tidal CO ₂	rScO ₂ decreased significantly from 79+/- 9 to 57+/-9% on the left side and 77+/-10 to 59+/-10% on the right side (P<0.001). A relative decrease in rScO ₂ of more than 20% occurred in 80% of the patients when placed in the BCP.	Only used NIRS to measure cerebral oxygenation. No other method used to confirm results. Did not assess for postoperative cognitive dysfunction
Murphy et al., 2010 Cerebral oxygen desaturation events assessed by near-infrared spectroscopy during shoulder arthroscopy in the beach chair and lateral decubitus positions.	Aim: Identify the incidence of CDEs during shoulder arthroscopy in the BCP or LDP Hypothesis: There will be 50% fewer CDEs in patients having surgery in the LDP. Independent variable: General anesthesia in the BCP or LDP Dependent variable: CDE (>20% decrease from baseline or absolute value <55% for >15 seconds)	Prospective, observational study	N = 124 BCP Group (61) Patients undergoing shoulder surgery with general anesthesia in the BCP. LDP Group (63) Patients undergoing shoulder surgery with general anesthesia in the LDP.	Scto ₂ (FORE-SIGHT), HR, MAP, SaO ₂ measured before positioning and then every 3 minutes	The incidence of CDEs was higher in the BCP group (80.3% vs 0% LDP), as was the median number of CDEs per subject (4, range 0-38 vs 0 LDP, all P<0.0001).	Only used NIRS to measure cerebral oxygenation. No other method used to confirm results. Baseline Scto ₂ values were collected after induction. Did not assess for neurocognitive dysfunction. Use of the FORE-SIGHT monitor rather than INVOS. INVOS has been used in the majority of studies regarding cerebral oximetry.
Salazar et al., 2013	Aim: To define the	Prospective, observational	N = 51	rSO ₂ (INVOS 5100)	The incidence of CDE was 18%, the mean time of	No control group

Reference	Research Question and Hypothesis	Study Design	Sample (N)	Methods for Data Collection and Data Analysis	Findings	Limitations
Cerebral desaturation during shoulder arthroscopy: A prospective observation study	<p>incidence, timing, and magnitude of CDEs in subjects undergoing arthroscopic shoulder surgery in the BCP.</p> <p>Independent variable: General anesthesia in the BCP</p> <p>Dependent variable: CDE (decrease of rSO₂ >20% from baseline)</p>	study	Patients undergoing shoulder surgery with general anesthesia in the BCP	Standard monitors (EKG, blood pressure cuff on non-operative arm, pulse oximetry, capnography, axillary temperature)	onset was 18 minutes and 38 seconds post induction, the mean maximal decrease in rSO ₂ was 32% from baseline	Did not assess for neurocognitive dysfunction.
Soeding et al., 2011 The effect of the sitting upright or 'beachchair' position on cerebral blood flow during anaesthesia for shoulder surgery.	<p>Aim: To investigate the effect of anesthetic-induced hypotension on estimated cerebral blood flow in patients placed in the BCP for shoulder surgery.</p> <p>Secondary aim to identify whether single vessel carotid blood flow could be used as a reliable index of total cerebral flow.</p> <p>Hypothesis: General anesthesia associated with hypotension would result in decreased CBF and would not be observed in patients receiving sedation rather than general anesthesia.</p>	Randomized prospective study	<p>N = 40</p> <p>General Group - General anesthesia with interscalene brachial plexus block (N = 20)</p> <p>Sedation Group - Intravenous sedation with interscalene brachial plexus block (N = 20)</p>	<p>Internal carotid artery blood flow (Siemens Acuson Antares Revision 5)</p> <p>MAP (NIBP cuff on the non-surgical brachial artery, and arterial line leveled at the tragus)</p>	<p>In the General Group, CBF did not change significantly after induction (P = .83) even though post induction MAP changed significantly (P < .05). No significant change in CBF after BCP was noted (P = .67). In the Sedation Group, CBF remained constant after BCP (P = .68).</p> <p>No significant change in MAP following BCP in the Sedation Group (P = .34). Significant change in MAP following BCP in the General Group (P < .01)</p> <p>NIBP at the arm significantly overestimated the MAP transduced at the tragus.</p> <p>No significant change in HR following BCP in General or Sedation Group</p>	Did not assess for neurocognitive dysfunction.

Reference	Research Question and Hypothesis	Study Design	Sample (N)	Methods for Data Collection and Data Analysis	Findings	Limitations
					(P = .51 and P = .49)	
Triplet et al., 2015 Cerebral desaturation events in the beach chair position: Correlation of noninvasive blood pressure and estimated temporal mean arterial pressure	Aim: To examine the correlations between brachial NIBP and eTMAP during CDE in the BCP Hypothesis: No correlation exists between NIBP and eTMAP with respect to rSO2 during a CDE. Variables: CDE is defined as a >20% drop in cerebral oxygenation from baseline.	Prospective cohort study	N = 57 Only those who experienced a CDE during their operation were included in the analysis (26 of the 57). Of these 26 patients, 45 CDEs were observed.	rSO2 (INVOS 5100) eTMAP (estimated using an invasive arterial BP transducer at the level of the temporal artery) NIBP (automated sphygmomanometer)	Median reduction in BIBP, eTMAP, and rSO2 from baseline to CDE were 48.2%, 75.5%, and 33.3%. At baseline, there was a significant weak correlation between rSO2 and NIBP (P=.045) and no significant associated between rSO2 and NIBP (P=.183). During CDEs, there was no significant correlation between rSO2 and NIBP (P=0.112) or between rSO2 and eTMAP (P=.212). No significant correlation between the decrease in rSO2 and NIBP (P=.675) or between rSO2 and eTMAP (P=.430) from baseline to CDE.	Did not assess for neurocognitive dysfunction. NIBP and eTMAP values only recorded during a CDE. Consistent time interval recording may have provided insight into the role of the variables before or after the CDE.

BCP = beach chair position, BIS = Bispectral Index, CBF = cerebral blood flow, CDE = cerebral desaturation event, CHR = central heart rate, COx = variable cerebral oximetry, EtCO2 = end-tidal carbon dioxide, eTMAP = estimated temporal mean arterial pressure, FiO2 = inspired oxygen fraction, ISB = interscalene block, LDP = lateral decubitus position, MAP = mean arterial blood pressure, NIRS = near-infrared spectroscopy, NIBP = non-invasive blood pressure, rSctO2/rSO2 = regional cerebral oxygen saturation, SaO2 = Peripheral O2 saturation, SctO2 = cerebral tissue oxygen saturation, SBP = systolic blood pressure, SpO2 = arterial oxygen saturation

APPENDIX C:
SITE AUTHORIZATION FORM

Site Authorization Form



University of Arizona Institutional Review Board
c/o Office of Human Subjects
1618 E Helen St
Tucson, AZ 85721

Please note that Mr. Michael Crosley, UA Doctor of Nursing Practice student, has permission of the [REDACTED] to conduct a quality improvement project at our facility for his project, "Practice Improvement by Implementing Cerebral Oximetry during Shoulder Surgery in the Beach Chair Position".

Mr. Crosley plans on presenting an educational PowerPoint to anesthesia providers regarding the use of cerebral oximetry in the beach chair position. A pre and post survey will be distributed to anesthesia providers to determine practice improvement for implementation of cerebral oximetry. The final project will be presented during Grand Rounds on November 11th, 2018. Mr. Crosley's activities will be completed by December 10th, 2018.

Mr. Crosley has agreed to provide to my office a copy of the University of Arizona IRB Approval form stating this project is not human research before the start of the project.

If there are any questions, please contact my office.

Signed,

[REDACTED]
Director of Grand Rounds
Division of Cardiovascular and Thoracic Anesthesiology
Assistant Professor in Anesthesiology
[REDACTED]

APPENDIX D:
PRESENTATION FLYER

Anesthesiology Grand Rounds
Monday, November 12, 2018



Time: 6:45 a.m. – 7:30 a.m.

Location: MH 01-115

**Practice Improvement by Implementing
Cerebral Oximetry During Shoulder Surgery
in the Beach Chair Position**

Presented by Michael Crosley, RN, BSN, SRNA

Participation in the survey and presentation is voluntary

APPENDIX E:
THE UNIVERSITY OF ARIZONA INSTITUTIONAL REVIEW BOARD (IRB) REVIEW



Human Subjects
Protection Program

1618 E. Helen St.
P.O.Box 245137
Tucson, AZ 85724-5137
Tel: (520) 626-6721
<http://rgw.arizona.edu/compliance/home>

Date: November 09, 2018

Principal Investigator: Michael William Crosley

Protocol Number: 1811086701

Protocol Title: PRACTICE IMPROVEMENT BY IMPLEMENTING CEREBRAL OXIMETRY DURING SHOULDER SURGERY IN THE BEACH CHAIR POSITION

Determination: Human Subjects Review not Required

Documents Reviewed Concurrently:

HSPP Forms/Correspondence: *Crosley_IRB Determination.pdf*

Informed Consent/PHI Forms: *Disclosure Statement copy.doc*

Regulatory Determinations/Comments:

- Not Research as defined by 45 CFR 46.102(d): As presented, the activities described above do not meet the definition of research cited in the regulations issued by U.S. Department of Health and Human Services which state that "research means a systematic investigation, including research development, testing and evaluation, designed to contribute to generalizable knowledge."

The project listed above does not require oversight by the University of Arizona.

If the nature of the project changes, submit a new determination form to the Human Subjects Protection Program (HSPP) for reassessment. Changes include addition of research with children, specimen collection, participant observation, prospective collection of data when the study was previously retrospective in nature, and broadening the scope or nature of the study activity. Please contact the HSPP to consult on whether the proposed changes need further review.

The University of Arizona maintains a Federalwide Assurance with the Office for Human Research Protections (FWA #00004218).

APPENDIX F:
LOCAL HOSPITAL HUMAN SUBJECTS REVIEW

From: IRBe

Sent: Thursday, October 25, 2018 12:06 PM

To: [REDACTED]

Subject: 18-009195 - An application has been deemed Not Research by IRB

Re: IRB Application #: 18-009195

Title: Practice Improvement by Implementing Cerebral Oximetry During Shoulder Surgery
in the Beach Chair Position

IRBe Protocol Version: 0.01

IRBe Version Date: 10/1/2018 3:58 PM

IRB Approval Date: 10/25/2018

IRB Expiration Date:

The IRB reviewed the above referenced application. The Reviewer noted that the application involves QI and determined that it does not constitute research as defined under 45 CFR 46.102.

Continued IRB review of this application is not required.

[REDACTED] Institutional Reviewer

APPENDIX G:
PRE-ASSESSMENT SURVEY

Pre-Assessment Survey

1. How many years have you practiced anesthesia?

- ☐ 0 – 4 years
- ☐ 5 – 9 years
- ☐ 10 – 19 years
- ☐ > 20 years

2. What is your clinical role?

- ☐ Certified Registered Nurse Anesthetist
- ☐ Anesthesiologist

3. From 1 (most often) to 3 (least often), please rank the types of surgeries in which you are most commonly involved.

	Most often (1)	Sometimes (2)	Least often (3)
Orthopedic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vascular	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cardiac	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. From 1 (most often) to 3 (least often), please rank the orthopedic surgeries in which you are most commonly involved.

	Most often (1)	Sometimes (2)	Least often (3)
Knee	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hip	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shoulder	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. How many cases per month do you use cerebral oximetry?

- ☐ 0
- ☐ 1 – 4
- ☐ 5 – 10
- ☐ > 10

6. How often do you use cerebral oximetry for the following procedures?

	0 (never)	1 (rarely)	2 (sometimes)	3 (often)	4 (always)	N/A
Orthopedic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vascular	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cardiac	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thoracic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. How many times in the last month did you use cerebral oximetry for shoulder surgeries in the beach chair position?

- ☐ 0
- ☐ 1 – 4
- ☐ 5 – 10
- ☐ > 10

8. What barriers have you encountered that inhibited the use of cerebral oximetry for shoulder surgery in the beach chair position?

- ☐ Cerebral oximetry not available
- ☐ Lack of time
- ☐ Too much trouble to apply pads and obtain a baseline
- ☐ I do not believe there is a benefit to using cerebral oximetry
- ☐ Other

Rationale:

9. Do you think there are any benefits to using cerebral oximetry for patients undergoing shoulder surgery in the beach chair position?

- ☐ Yes
- ☐ Maybe
- ☐ No

Rationale:

10. Do you feel that the information received from the cerebral oximeter changed your anesthetic plan?

- ☐ Yes
- ☐ Maybe
- ☐ No

Rationale:

11. How beneficial do think cerebral oximetry is?

- ☐ Very useful
- ☐ Somewhat useful
- ☐ Not particularly useful
- ☐ Not useful at all
- ☐ Unsure

Rationale:

APPENDIX H:
FOLLOW-UP SURVEY

Follow-up Survey

1. How many cases per month do you use cerebral oximetry?

- ☐ 0
- ☐ 1 – 4
- ☐ 5 – 10
- ☐ > 10

2. How often do you use cerebral oximetry for the following procedures?

	0 (never)	1 (rarely)	2 (sometimes)	3 (often)	4 (always)	N/A
Orthopedic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vascular	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cardiac	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thoracic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. How many times in the last month did you use cerebral oximetry for shoulder surgeries in the beach chair position?

- ☐ 0
- ☐ 1 – 4
- ☐ 5 – 10
- ☐ > 10

4. What barriers have you encountered that inhibited the use of cerebral oximetry for shoulder surgery in the beach chair position?

- ☐ Cerebral oximetry not available
- ☐ Lack of time
- ☐ Too much trouble to apply pads and obtain a baseline
- ☐ I do not believe there is a benefit to using cerebral oximetry
- ☐ Other

Rationale:

5. Do you think there are any benefits to using cerebral oximetry for patients undergoing shoulder surgery in the beach chair position?

☐ Yes

☐ No

Rationale:

6. Do you feel that the information received from the cerebral oximeter changed your anesthetic plan?

☐ Yes

☐ No

Rationale:

7. How beneficial do think cerebral oximetry is?

☐ Very useful

☐ Somewhat useful

☐ Not particularly useful

☐ Not useful at all

☐ Unsure

Rationale:

APPENDIX I:
LICENSE AGREEMENT FOR SURVEY TOOL

ELSEVIER LICENSE TERMS AND CONDITIONS

Jun 03, 2018

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Expected completion date	May 2019
Estimated size (number of pages)	50

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APPENDIX J:
DISCLOSURE STATEMENT

**Practice Improvement by Implementing Cerebral Oximetry During
Shoulder Surgery in the Beach Chair Position
Michael Crosley**

The purpose of this Doctor of Nursing Practice (DNP) project is to improve healthcare outcomes through translation of current knowledge into practice within the [REDACTED] Hospital. The goals are to identify barriers and evaluate the change in perceived benefit and implementation of cerebral oximetry for shoulder surgery in the beach chair position (BCP) following an educational presentation.

If you choose to take part in this project, you will be asked to complete a paper survey prior to attending an educational presentation. Four weeks after the presentation, you will be asked to complete a follow up survey. Each survey will take approximately 10 minutes to complete. There are no foreseeable risks associated with participating in this project and you will receive no immediate benefit from your participation. Survey responses are anonymous.

If you choose to participate in the project, participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw at any time from the project. In addition, you may skip any question that you choose not to answer. By participating, you do not give up any personal legal rights you may have as a participant in this project.

For questions, concerns, or complaints about the project, you may call or email Michael Crosley RN, BSN, SRNA.

Principal Investigator:
Michael Crosley RN, BSN, SRNA
Phone: (480) 628-5773
Email: mcrosley@email.arizona.edu

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